



Standard Specification for Glass Fiber Mechanically Bonded Felt Thermal Insulation¹

This standard is issued under the fixed designation C1086; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers glass fiber unsupported needled felt (mechanically bonded) binder-free insulation for thermal insulation. This material is used as the thermal insulation component in the fabrication of insulation systems for use on machinery and equipment, such as steam turbines, boilers, boiler feed pumps, and piping at temperatures from ambient up to 1200°F (650°C).

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 See Supplementary Requirements for modifications to paragraphs in this standard when using Specification C1086 in lieu of the United States Department of Defense, Department of Navy, Naval Sea Systems Command, in Washington, DC. Military Specifications No.(s) MIL-I-16411F.

2. Referenced Documents

2.1 ASTM Standards:²

- C167 Test Methods for Thickness and Density of Blanket or Batt Thermal Insulations
- C168 Terminology Relating to Thermal Insulation
- C177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
- C335 Test Method for Steady-State Heat Transfer Properties of Pipe Insulation

¹ This specification is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.23 on Blanket and Loose Fill Insulation.

Current edition approved May 1, 2009. Published June 2009. Originally approved in 1987. Last previous edition approved in 2008 as C1086 – 08. DOI: 10.1520/C1086-09.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

C390 Practice for Sampling and Acceptance of Thermal Insulation Lots

C411 Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation

C518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

C1045 Practice for Calculating Thermal Transmission Properties Under Steady-State Conditions

C1058 Practice for Selecting Temperatures for Evaluating and Reporting Thermal Properties of Thermal Insulation

D123 Terminology Relating to Textiles

D578 Specification for Glass Fiber Strands

2.2 U.S. Federal Standard:

FED-STD-191 Textile Test Methods³

2.3 U.S. Military Standards:

MIL-I-16411F Insulation Felt, Thermal, Glass Fiber³

MIL-STD-1623 Fire Performance Requirements and Approved Specifications for Interior Finish Materials and Furnishings (Naval Shipboard Use)³

3. Terminology

3.1 Definitions:

3.1.1 Terminology C168 and D123 shall be considered as applying to the terms used in this specification.

3.1.2 Definitions in Specification D578 shall be considered as applying to the terms used in defining glass fiber composition code, process, and fiber diameter.

4. Classification

4.1 Thermal insulation shall be glass fiber, unsupported needled felt insulation, for use on surfaces with temperatures up to 1200°F (650°C).

5. Ordering Information

5.1 The purchase order or contract shall specify the following:

5.1.1 Quantity of each thickness (10.1).

5.1.2 Any special requirements for nonstandard sizes or dimensions (10.2 and 10.3).

5.1.3 Any requirements for certification (19.1).

³ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://www.dodssp.daps.mil>.

5.1.4 Any special requirements for supplementary testing requirements (9.1). and

5.1.5 Any special packaging information.

6. Materials and Manufacture

6.1 The material shall consist of 100 % glass fiber needled into insulation felts without the use of binders. No organic fibers and no glass or mineral shot shall be included in the product. It is acceptable for the insulation felt to be composed of laminates formed without the use of binders. The glass fibers shall meet the designation C, Continuous Filament Yarns, in accordance with Specification D578 (see Note 1).

6.2 The fiber diameter of the glass fiber used in the final product, when determined in accordance with the Filament Diameter section of Specification D578 shall conform to the requirements of Table 1. The certification of the diameter of the fiber is to be provided in one of two ways: either by the felt manufacturer or by certification of the glass fiber supplier and documentation by the manufacturer as to sources of supply.

6.3 All materials used shall be asbestos and ceramic (refractory) fiber-free.

NOTE 1—The fibers from glass composition designated as “E” glass (electrical glass) in the range from D through G meet the requirements of Tables 1 and 2.

7. Physical Properties

7.1 When tested in accordance with Section 16, the insulation shall conform to the physical requirements listed in Table 2.

8. Performance Characteristics

8.1 Any of the following conditions can result in damage to the needled glass fiber insulation:

- 8.1.1 Direct exposure to hydrofluoric acid.
- 8.1.2 Prolonged direct exposure to strong caustics.
- 8.1.3 Prolonged exposure to boiling water.

8.2 Conditions outlined in 8.1 are mentioned only to make the user aware of such applications that require special consideration. Contact the insulation manufacturer for recommendations when the above conditions are anticipated.

9. Other Requirements

9.1 Supplementary requirements include qualification tests and acceptance tests to special standards. These supplementary requirements are made by agreement to the supplier and the purchaser only when specified in the purchase order or contract.

10. Standard Sizes and Dimensions

10.1 *Thickness*—The insulation shall be furnished in the thicknesses shown in Table 3.

TABLE 1 Requirements for Diameter of Fiber

Diameter of Fiber	Inch (Millimetre)
Average diameter shall not exceed	0.00036 (0.009)
90 % shall be less than	0.00040 (0.102)

TABLE 2 Physical Requirements

Thickness, length of roll	See Table 3
Mass per unit area	See Table 4
Apparent Thermal Conductivity, Max ^a	
Btu in./h ft ² F (W/mK) at mean temp. of:	
75°F (24°C)	0.29 (0.042)
300°F (149°C)	0.40 (0.058)
500°F (260°C)	0.50 (0.072)
700°F (371°C)	0.65 (0.094)
Hot Surface Performance at 1200°F (650°C)	no melting, no significant shrinkage (max 5 %)
Tensile strength: psi (kPa)	
Minimum	5 (34.5)
Non-Combustibility	Pass

^aIt is possible that the thermal transmission properties of felted glass fiber thermal insulation will vary with temperature, temperature gradient, thickness and shape. Note that the apparent thermal conductivity requirements specified in the table are based on samples tested under conditions specified in 16.1.3. These are comparative values for establishing specification compliance and it is possible that they do not represent the installed performance of the insulation under use conditions of the insulation differing substantially from the test conditions.

TABLE 3 Standard Dimensions

Nominal Thickness, in. (mm)	Insulation Length, ft (m)
0.3 (7.6)	150 (45.2)
0.5 (12.7)	75 (22.9)
0.75 (19.1)	45 (13.7)
1.0 (25.4)	45 (13.7)

10.2 *Insulation Length*—Unless otherwise specified, the insulation shall be furnished in rolls of the lengths given in Table 3.

10.3 *Insulation Width*—Unless otherwise specified (5.1.2), the width of the insulation shall be 60 in. (1.52 m).

10.4 *Nominal Mass per Area*—The insulation shall be furnished in the mass per area shown in Table 4.

11. Dimensional Tolerances

11.1 *Thickness Tolerance*—The average thickness as determined in accordance with 16.1.1 shall be within ± 0.125 in. (3.2 mm) of the specified thickness.

11.2 *Mass per Area Tolerance*—The average mass per area shall be within ± 10 % of that specified in Table 4.

11.3 *Insulation Length/Tolerance*—The tolerance on the lengths, listed in Table 3, shall be -6 in. (-152 mm), with excess permitted. It is acceptable for a roll to contain either a maximum of one full thickness splice or consist of a maximum of two pieces.

11.4 *Width*—The width shall be within -0.5 in. (13 mm), to $+1.0$ in. (25 mm) of the specified width.

TABLE 4 Standard Parameters

Nominal Thickness, in. (mm)	Mass per Area oz/ft ² (kg/m ²)
0.3 (7.6)	3.5 (1.07)
0.5 (12.7)	6.0 (1.83)
0.75 (19.1)	12.25 (3.74)
1.0 (25.4)	15.0 (4.58)

12. Workmanship, Finish, and Appearance

12.1 Since some requirements for this material are not easily defined by a numerical value, the insulation shall not have visible defects that will adversely affect its service qualities.

13. Qualification Requirements

13.1 The following requirements are generally employed for the purpose of initial material or product qualification in accordance with Practice C390:

- 13.1.1 Standard sizes and dimensions,
- 13.1.2 Apparent thermal conductivity,
- 13.1.3 Diameter of fiber,
- 13.1.4 Hot surface performance,
- 13.1.5 Tensile strength, and
- 13.1.6 Non-combustibility.

14. Sampling

14.1 The insulation shall be sampled for qualification testing and for inspection in accordance with Practice C390. Specific provision for sampling shall be agreed upon between the purchaser and the supplier.

15. Inspection Requirements

15.1 *Inspection for Quality Assurance*—The following requirements are generally employed for purposes of acceptance sampling of lots or shipments of qualified felted insulation.

- 15.1.1 Thickness.
- 15.1.2 Mass per unit area.

15.2 *Points of Inspection*—When agreed to by the purchaser and the manufacturer, and when specified in the purchase order or contract, the inspection of the material shall be made at either the point of shipment or point of delivery.

16. Test Methods

16.1 The properties enumerated in this specification shall be determined in accordance with the following test methods:

16.1.1 *Thickness*—Test Methods C167. Follow the specified pressure alternative procedure of Test Methods C167 except that the expansion procedure for sample preparation is not necessary. A test specimen shall be taken that is 4 ft long by the full width of the insulation felt. The test specimen shall be ruled off into 20 approximately square and equal areas, and the thickness measurement taken at the center of ten areas, no two of which shall have a contiguous side. The specimen shall be placed on a hard flat surface and the thickness shall be measured using a dial gage indicator. The gage shall have a circular presser foot 3–4 in. (76–102 mm) in diameter. The foot shall exert a pressure of 0.1 lb/in.² (7 gm/cm²) $\pm$ 10 %. The gage shall be calibrated before use with a gage block. The average of the ten thickness measurements shall be taken as the thickness of the test specimen.

16.1.2 *Area Weight*—Test Methods C167, except that the expansion procedure for sample preparation is not necessary. The weight per unit area shall be reported in ounces per square foot (kilograms per square metre). The test specimen shall be 4 ft long by the full width of the felt. It is acceptable for the

specimen taken for the thickness measurement to be used for the weight per unit area measurement.

16.1.3 *Apparent Thermal Conductivity*—Apparent thermal conductivity shall be determined in accordance with Test Methods C177, C335 or C518. In case of dispute, Test Method C177 shall be used.

16.1.3.1 See Practice C1045 for requirements and guidelines for the determination of thermal transmission properties.

16.1.3.2 See Practice C1058 for guidelines for reporting thermal properties.

16.2 *Hot Surface Performance*—Test Method C411. The test temperature shall be that specified in 3.1, or the manufacturer's recommended temperature, whichever is higher.

16.3 *Tensile Strength*—The tensile strength shall be determined by the grab test method described in Method 5100 of FED-STD-191 with the following exceptions: The test sample shall be from 12 to 14 in. long by the full width of the felt. Five test specimens measuring 12 in. in the width direction by 12 to 14 in. (305 by 355 mm) long shall be cut from the sample. The specimens shall be clamped at the top and bottom sections by a nominal ½ in. (12 mm) pipe covered with 0.25-in. (6-mm) thick sponge rubber to prevent cutting and slipping of the specimens. The clamped specimens, having a test area of about 1 ft² (0.09 m²) shall be attached to the grips of the testing machine that shall separate at a rate of 2 $\pm$ 0.2 in. (51 $\pm$ 5 mm)/min until rupture occurs. Tensile strength determinations shall be made on specimens before and after being subjected to soaking heat to 1200°F (650°C) for 6 h. The tensile strength shall be expressed in pounds per square inch (kilopascals) based on the nominal cross-sectional area. The tensile strength for purposes of determining conformance shall be the average of the five measurements on these specimens (see Table 2).

16.4 *Noncombustibility*—Test method USCG 164.009 (in accordance with MIL-STD-1623) or IMO 1182:1990 per FTP Code Annex, Part 1.

17. Rejection and Rehearing

17.1 It is acceptable to reject material that fails to conform to the requirements of the agreed upon specification. Rejection shall be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of the test, the producer or the supplier may make claim for a rehearing.

17.2 The certification of an independent third party indicating conformance to the requirements of this specification is an acceptable substitute to the manufacturer's certification, upon the request of the purchaser in the contract or order.

17.3 In case of rejection, the manufacturer or supplier shall have the right to reinspect the rejected shipment and resubmit the lot after removal of the portion of the shipment not conforming to the specified requirements.

18. Certification

18.1 When specified in the purchase order or contract, the producer or the supplier shall furnish a certificate to the purchaser that the material was manufactured, sampled, and tested or inspected in accordance with this specification and has been found to meet the requirements. The supplier shall

furnish a summary of the documentation of the qualification test results or the inspection test results, or both, upon request.

19. Packaging and Package Marking

19.1 *Packaging*—Unless otherwise agreed upon or specified between the purchaser and manufacturer or supplier, insulation shall be packed in the manufacturer's standard commercial containers.

19.2 *Package Marking*—Unless otherwise specified, each container shall be plainly marked with the manufacturer's name, the product name, and quantity of the material in the container.

20. Keywords

20.1 binder free; glass fiber felt; glass fiber; needled felt

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall apply only when specified by purchaser in contract or order when Specification C1086 replaces Military Specification No. MIL-I-16411F for use by the U.S. Department of Defense, Department of Navy and Naval Sea Systems Command.

S1. Add 13.1.7 Alkalinity and 13.1.8 Fusing Temperature to Section 13, Qualification Requirements :

S1.1—13.1.7 Alkalinity

S1.2—13.1.8 Fusing Temperature

S2. Add 16.5 Alkalinity and 16.6 Fusing Temperature to Section 16, Test Methods

S2.1—16.5 Alkalinity—A 0.176 oz $\pm$ 0.00035 oz (5 $\pm$ 0.01 g) representative test specimen of the felt, shall be weighed and placed in a 17 oz (500 mL) pyrex Erlenmeyer flask. The test specimen shall be wetted with 0.17 oz (5 mL) of 95 percent ethyl alcohol and 13.5 oz (400 mL) of distilled water, and refluxed for 4 h $\pm$ 5 minutes. At the end of this period, the condenser shall be disconnected and the sample filtered at once through a number 41 Whatman paper, or equal, supported in a Buechner funnel and connected to a suction source. The flask and residual material shall be washed three times with 0.85 oz (25-mL) portion of hot distilled water. Next, the combined filtrate and wash solution shall be titrated immediately with 0.02N H₂SO₄ using 6 to 8 drops of a 1 percent solution of phenol-red indicator, to the disappearance of the pink color. A blank determination shall be run on the total amount of distilled water and alcohol and the titration value shall be substituted in the formula below. The alkalinity of the finished material expressed as sodium oxide (Na₂O) shall not exceed 0.20 percent. Percent alkalinity expressed as: $Na_2O = ((A-B)N / W$

$$Na_2O = ((A - B) N \times 0.031 \times 100) / W$$

Where:

A = mL H₂SO₄ required to titrate sample.

B = mL H₂SO₄ required to titrate the blank

N = Normality of the H₂SO₄.

W = Weight of sample in grams.

S2.2—16.6 Fusing Temperature —A 0.035 oz (1 g) sample of glass fiber shall be weighed and placed into a crucible which shall be placed in a muffle furnace at room temperature. Heating elements shall be turned on at the start of the test and adjusted so that the specified temperature of 1300 °F (704°C) is reached within 45 $\pm$ 10 minutes. When this temperature is reached, the crucible shall be removed from the furnace immediately, allowed to cool, and examined visually for fusion. Fusion shall be considered to have taken place if any part of the sample has melted and formed a homogenous mass. The fusing temperature of the fibers shall not be less than 1300 °F (704°C) .

S3. Add to Table 2 Physical Requirements:

TABLE 2 Physical Requirements

Alkalinity	Expressed as sodium oxide (Na ₂ O) max 0.20%
Fusing Temperature	Shall not be less than 1300°F (704°C)

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